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# **PROVISIONAL APPLICATION FOR PATENT COVER SHEET**

This is a request for filing a **PROVISIONAL APPLICATION FOR PATENT** under 37 CFR 1.53(c).

Express Mail Label No. **ER 047839835 US**

INVENTOR(S)				
Given Name (first and middle (if any))		Family Name or Surname		Residence (City and either State or Foreign Country)
Young		SEO		Ann Arbor, Michigan
<input type="checkbox"/> Additional inventors are being named on the _____ separately numbered sheets attached hereto				
TITLE OF THE INVENTION (500 characters max)				
ELECTROMAGNETIC BLANK RESTRAINER				
Direct all correspondence to: <b>CORRESPONDENCE ADDRESS</b>				
<input checked="" type="checkbox"/> Customer Number		04859		
OR				
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ENCLOSED APPLICATION PARTS (check all that apply)				
<input checked="" type="checkbox"/> Specification Number of Pages		5		
<input type="checkbox"/> Drawing(s) Number of Sheets		<input type="checkbox"/> CD(s), Number		
<input type="checkbox"/> Application Data Sheet. See 37 CFR 1.76		<input checked="" type="checkbox"/> Other (specify) Assignment		
METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT				
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27.		FILING FEE AMOUNT (\$)		
<input type="checkbox"/> A check or money order is enclosed to cover the filing fees				
<input checked="" type="checkbox"/> The Director is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number		13-0005		
<input type="checkbox"/> Payment by credit card. Form PTO-2038 is attached.		\$80.00		
The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.				
<input checked="" type="checkbox"/> No.				
<input type="checkbox"/> Yes, the name of the U.S. Government agency and the Government contract number are: _____				

Respectfully submitted,

SIGNATURE

Date

REGISTRATION NO.

17,919

TYPED OR PRINTED NAME

Donald R. Fraser

(if appropriate)

Docket Number:

1-36919

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419-874-1100

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**CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)**

Docket No.

Applicant(s): Young Seo

1-36919

Serial No.

Filing Date

Examiner

Group Art Unit

Invention:

**ELECTROMAGNETIC BLANK RESTRAINER**

I hereby certify that the following correspondence:

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is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on

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TITLE**ELECTROMAGNETIC BLANK RESTRAINER**BACKGROUND OF THE INVENTION

5           1. Field of the Invention: The invention relates to sheet metal stamping operations and more particularly to an electromagnetic means for restraining the blank of sheet metal during a metal forming operation.

          2. Description of the Prior Art: Sheet metal  
10 forming processes are typically employed in industries such as for example automotive, appliances, military, and electronic. The elimination of defects in the sheet metal during the sheet metal forming process has been the subject of considerable study. The defects which  
15 typically occur during the forming process include tearing, plastic buckling or wrinkling, and elastic recovery or spring back upon unloading. Certain of these defects can be effectively minimized by controlling the blankholder or binder force and drawbead  
20 penetration which relate to the restraining forces applied to the sheet metal blank during a metal forming operation. By controlling and/or varying the blankholder force (BHF) during the sheet metal forming operation, certain defects can be eliminated and the  
25 formability of the product can be improved.

          It has been found that by improved blankholder force application to the sheet metal blank being formed, better control of wrinkling and fracturing of the metal can be achieved. Also, it has been found that improved

thickness profiles and reduced springback are effected. However, the conventional hydraulic stamping presses, for example, hydraulic cushions as the means to exert the blankholder force, are limited due to the limited  
5 space available in the press and the complexity of the required hydraulic system.

It is an objective of the present invention to produce an electromagnetic blank restrainer which will overcome the shortcomings of the prior blank restraining  
10 systems.

Another objective of the invention is to produce an electromagnetic blank restrainer utilizing the benefits of variable blank holding forces created by the utilization of electromagnetic forces, either attraction  
15 or retraction, to restrain the blank of sheet metal during a forming process of the sheet metal.

Still another objective of the invention is to produce an electromagnetic blank restrainer for applying variable forces created by a plurality of cooperating  
20 magnetic components to control the forces acting to restrain the blank of sheet metal during a stamping operation to form the blank into a stamped part.

#### SUMMARY OF THE INVENTION

25 The above objectives and advantages of the invention may typically be achieved by an apparatus for forming an article from a blank of sheet metal comprising a first die member having a cavity formed therein, a plurality of electromagnets disposed in

spaced relation about the cavity in the die for restraining movement of the blank of sheet metal; a second die member mounted for reciprocal movement toward and away from the cavity formed in the first die member; means for imparting selective reciprocal movement of the second die member; and control means for selectively energizing the plurality of electromagnets to restrain movement of the blank of sheet metal during the reciprocal movement of the second die.

10     DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Attractive or repulsive force on magnetic materials, as well as repulsive force on non-magnetic materials created by electromagnetic field, are the intrinsic properties of electromagnetism adopted in electromagnetic blank restrainer of the invention which is designed to exert on the magnetic blank a restraining force that is conventionally exerted by solid blankholder and drawbeads. Because of the compact size and inexpensive manufacturing cost, the restrainer can eliminate bulky and expensive blankholders of the prior art. The cost can be only a fraction of the current blankholders cost and, at the same time, the fabrication or tooling labors and hours can be tremendously reduced.

The same benefits of the prior art systems can be achieved with the invention while replacing the hydraulic control system with swift and accurate electronic control devices, which provides more flexibility and functionality only by varying the input of the energizing power. The control system of the

invention is more accurate and prompt because the response time of current is swifter than that of hydraulic fluid, the system is fully automated with desired control schemes. When it is used to replace the  
5 drawbeads, the invention eliminates the plastic deformation with drawbeads while preserving the ductility of sheet metal blank before it enters a die. The size of the blank is reduced resulting in material saving since it is possible to eliminate the flange area  
10 denting by drawbeads after forming.

The attracting forces are generally considered when dealing with electromagnetic restraining devices. However, the repelling forces are also considered to be important. An example is illustrated in Fig. 1 wherein  
15 there is disclosed a coil, a non-ferrous blank restrainer, and a workpiece which may be magnetic or non-magnetic material. A typical example may utilize a workpiece of a magnetic material such as steel or a non-magnetic material such as aluminum, for example.

20 By causing an electrical current to pass through the coil, an eddy current is developed in the coil and the associated non-ferrous (aluminum) blank restrainer. The eddy current produced in the coil and the blank restrainer result in repelling forces. Thus, by proper  
25 fixturing, the non-ferrous blank restrainer may be caused to move into intimate pressure contact with the workpiece and this force will act to restrain movement of the workpiece whether magnetic or non-magnetic.

As a general rule, the magnetic field patterns



provided by known electromagnets are discontinuous. This discontinuity is typically a result of the space occupied by the associated coils of the electromagnet. Surprisingly, the present invention has produced an  
5 interlocking electromagnet design wherein the interlocking electromagnets produce a continuous magnetic field on the surface of the magnet without any discontinuity of the magnetic field otherwise caused by the spacing of the associated coils.

10 The novel design eliminates the discontinuity typically exhibited by commercially available electromagnets and overcomes the otherwise limiting factor by inducing a full magnetic force on magnetic objects in contact therewith.

15 The attached pages A, B, and C disclose the structure of an interlocking electromagnet (ILEM). The attached pages D and E disclose in schematic form the use of an electromagnetic blank restrainer (EMBR) utilizing the principle of the present invention. The  
20 illustrations and description disclose the use of an electromagnetic blank restrainer in lieu of the conventional blankholder in connection with the forming by a stamping operation of a sheet metal workpiece.

The workpiece is held by an electromagnet of the  
25 present invention. The electromagnet is effective to control the movement of the sheet metal workpiece or blank during the drawing of the metal blank to form a cup shaped product.

In accordance with the provisions of the patent

statutes, the present invention has been described in what is considered to represent its preferred embodiment. However, it should be understood that the invention can be practiced otherwise than as  
5 specifically illustrated and described without departing from its spirit or scope.

CLAIMS

WHAT IS CLAIMED IS:

Apparatus for forming an article from a blank of sheet metal comprising:

5           a first die member having a cavity formed therein;

          a plurality of electromagnets disposed by spaced relation about the cavity in said die for restraining movement of the blank of sheet metal;

10           a second die member mounted for reciprocal movement toward and away from the cavity formed in said first die member;

          means for imparting selective reciprocal movement of said second die member; and

15           control means for selectively energizing said plurality of electromagnets to restrain movement of the blank of sheet metal during the reciprocal movement of said second die.

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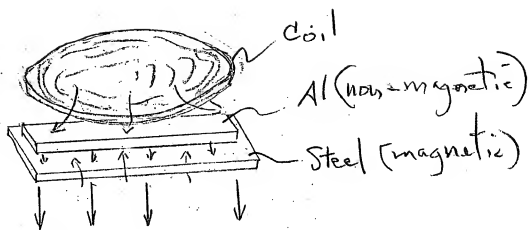


FIG. 1